Supplemental Specification
2005 Standard Specification Book

SECTION 03055

PORTLAND CEMENT CONCRETE

Delete Section 03055 and replace with the following:

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Materials and procedures for producing Portland Cement Concrete.

1.2 RELATED SECTIONS

A. None.

1.3 REFERENCES

A. AASHTO M 6: Standard Specification for Fine Aggregate for Portland Cement Concrete

B. AASHTO M 80: Standard Specification for Coarse Aggregate for Portland Cement Concrete

C. AASHTO M 154: Standard Specification for Air-Entraining Admixtures for Concrete

D. AASHTO M 157: Standard Specification for Ready-Mixed Concrete

E. AASHTO M 194: Standard Specification for Chemical Admixtures for Concrete

F. AASHTO M 295: Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

G. ASTM C 150: Standard Specification for Portland Cement

H. ASTM C 595: Standard Specification for Blended Hydraulic Cements

I. ASTM C 1157: Standard Performance Specification for Hydraulic Cement

J. ASTM C 1240: Standard Specification for Silica Fume for Used in Cementitious Mixtures

K. ASTM C 1567: Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)

L. ASTM C 1602: Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete

M. American Concrete Institute (ACI) Standards

N. Precast/Prestressed Concrete Institute (PCI)

O. UDOT Materials Manual of Instruction

P. UDOT Minimum Sampling and Testing Requirements Manual

Q. UDOT Quality Management Plan

1.4 SUBMITTALS

A. Furnish to the Engineer a mix design for each class of concrete to be used.
   1. Base concrete mix designs for all "A" concrete classes on trial batch test results or on UDOT's past project history (same materials used in previous mix designs within the past year).
   2. Use the same components in the trial batches that are to be used in the project including coarse and fine aggregate, water, source and type of cement, air-entraining agent, fly ash, etc., including any site-added admixtures intended to be used.
   3. Unless specified otherwise, do not exceed 30 percent total pozzolan in any mix.
   4. The Department or its representative witnesses the trial batch.
   5. Mix concrete (trial batches) as specified in UDOT Materials Manual of Instruction Part 8-974: Guidelines for Portland Cement Concrete Mix Design.
   6. Meet the following additional requirements for Self Consolidating Mixes (SCC):
      a. Design and mix according to ACI Manual of Concrete Practice 301: Specifications for Concrete.
      b. Provide mix specific flow and/or spread criteria.
      c. Meet PCI – TR-6-03. A visual stability index rating of 0 – 1 is required.
      d. Provide compressive strength data.

e. Include documentation justifying any deviation from the aggregate operating bands required by Table 4 with the mix design for approval. Production may not begin until the deviation is approved.

B. Verification that cement used is from a pre-qualified supplier. See this Section, article 2.1, paragraph.E.

C. Verification that fly ash used in from a pre-qualified supplier. See this Section, article 2.5, paragraph A.1.d.

1.5 ACCEPTANCE

A. Acceptance is in accordance with UDOT Minimum Sampling and Testing Requirements.

B. When concrete is below specified strength and does not have a separate strength pay factor:
1. Department may accept item at a reduced price.
2. The pay factor will be applied to the portion of the item that is represented by the strength tests that fall below specified strength.
3. Department will calculate the pay factor as follows (based on 28 day compressive strength):

Psi below specified strength:	**Pay Factor:**
1 – 100	0.95
101 – 200	0.90
201 – 300	0.85
301 – 400	0.80
More than 400	0.50 or Engineer may reject

PART 2 PRODUCTS

2.1 CEMENT

A. Use Type II Portland Cement, or Blended Hydraulic Cement, unless otherwise specified. (ASTM C 150, ASTM C 595, ASTM C 1157)

B. Portland Cement
1. Follow Tables 1 and 3 in ASTM C 150.
2. Follow the requirements of Table 2 of ASTM C 150 for low-alkali cement.

C. Blended Hydraulic Cement.

1. When Blended Hydraulic Cement is substituted for Portland Cement
   a. Use ASTM C 1567 to verify that expansion is less than 0.1 percent at 16 days.
   b. Refer to the equivalent cements listed in Table 1.
2. When adding flyash to a blended hydraulic cement ensure that the 30 percent total pozzolan limit is not exceeded.
   a. Submit documentation of the total pozzolan content with the mix design.

Table 1

Portland Cement/Blended Hydraulic Cement Equivalencies		
ASTM C 150 (Low Alkali)	**ASTM C 595**	**ASTM C 1157**
Type I	IP	GU
Type II	IP (MS)	MS
Type III	-	HE
Type V	-	HS

D. Do not use cement that contains lumps or is partially set.

E. Use cement from the list of UDOT qualified suppliers list maintained by the UDOT Materials Quality Assurance Section.

F. Do not mix cement originating from different sources.

G. Do not use air-entrained cement.

H. Department will sample and test the cement in accordance with UDOT Quality Management Plan 502: Cement.

2.2 AGGREGATE

A. Coarse Aggregate for Normal Concrete Mixes

1. Use coarse aggregate meeting AASHTO M 80 physical properties. Use one of the gradations found in Table 2.
2. Do not exceed 1 percent of deleterious substances as shown in AASHTO M 80, Table 2, for Class A aggregates (material finer than No. 200 sieve: maximum allowable 1 percent, exception as noted in footnote d).

Table 2

Aggregate Gradations - Percent Passing (by weight)								
Aggregate or Sieve Size (inches)	**2-1/2**	**2**	**1-1/2**	**1**	**3/4**	**1/2**	**3/8**	**No. 4**
2 to No. 4	100	95-100		35-70		10-30		0-5
1-½ to No. 4		100	95-100		35-70		10-30	0-5
1 to No. 4			100	95-100		25-60		0-10
¾ to No. 4				100	90-100		20-55	0-10

B. Fine Aggregate for Normal Concrete Mixes

1. Use fine aggregate meeting AASHTO M 6 physical properties. Use the gradation found in Table 3.
2. Do not exceed 3.0 percent of deleterious substances as outlined in AASHTO M 6, Table 2, for class A aggregates, using option "b" for material finer than the No. 200 sieve (material finer than No. 200 sieve: maximum allowable 3 percent).

Table 3

Gradation	
Sieve Size	**Percent Passing (by weight)**
$^{3}/_{8}$ inch	100
No. 4	95 to 100
No. 16	45 to 80
No. 50	10 to 30
No. 100	2 to 10

C. Coarse and Fine Aggregate for Self Consolidating Concrete (SCC) Mixes.

1. Combined gradations of coarse and fine aggregates must be within the bands shown in Table 4. Establish targets and production tolerances necessary to meet the requirements of Table 4.

Table 4

Aggregate Gradations (Percent Passing by Dry Weight of Aggregate)		
Sieve Size	**¾ inch Operating Bands**	**½ inch Operating Bands**
¾ inch	95 – 100	–
½ inch	65 – 95	95 –100
$^{3}/_{8}$ inch	58 – 83	65 – 95
No. 4	35 – 65	50 – 80
No. 8	25 – 50	30 – 60
No. 16	15 – 35	20 – 45
No. 30	10 – 35	12 –35
No. 50	5 – 20	5 – 20
No. 100	1 – 12	2 – 12
No. 200	0 – 2	0 – 2

2.3 WATER

A. Use potable water or water meeting ASTM C 1602, including Table 2.

B. Screen out extraneous material when pumping water from streams, ponds, lakes, etc.

2.4 ADMIXTURES

A. Air Entrainment: as specified. Meet AASHTO M 154, including Section 5.

B. Water Reducing Agents/Accelerators: The chlorides content (as Cl-) must not exceed 1 percent by weight of the admixtures. Meet AASHTO M 194.

1. High Range Water Reducer (HRWR): Submit a written plan for approval with the trial batch that shows proper attention will be given to ingredients, production methods, handling and placing.
2. Do not use calcium chloride.

C. Set Retarding Admixtures: If set retarding admixtures are required due to haul times exceeding the time limitations in this Section, article 3.4, paragraph A, establish the effective life of the set-retarding admixture by trial batch.

1. Do not exceed any manufacturer recommendations for the use of the set-retarding admixture.
2. Do not re-dose the concrete with additional set retarding admixture.
3. Add set retarding admixture at the batch plant at the time of initial batching operations.

4. Show on batch tickets the amount of admixture used.
5. Time of placement is established by the trial batch and supersedes the requirements in this Section, article 3.4, paragraph A.

D. Viscosity Modifying Admixtures.
1. Do not exceed any manufacturer recommendations for the use of the viscosity modifying admixture.
2. Do not re-dose the concrete with additional viscosity modifying admixture.
3. Show on batch tickets the amount of admixture used.

E. Site-added admixtures.
1. Use admixture in the trial batch.
2. Use pre-measured admixtures only.
3. Record amount used on batch ticket.
4. Rotate the drum at least 30 revolutions at the mixing speed recommended by the manufacturer.

2.5 POZZOLAN

A. Fly Ash:
1. Class F, as specified. Conform to AASHTO M 295 except table 2.
   a. Unless specified otherwise, replace a minimum of 20 percent of the Portland cement by weight. Use the minimum cement content in the design formulas before replacement is made.
   b. Loss on Ignition (LOI): not to exceed 3 percent.
   c. Maximum allowable CaO content: not to exceed 15 percent.
   d. Use fly ash from the list of UDOT pre-qualified sources maintained by the UDOT Materials Quality Assurance.
   e. Label the storage silo for fly ash to distinguish it from cement.
   f. Use different size unloading hoses and fittings for cement and fly ash.
2. Fly ash may be sampled and tested for compliance at any time.

B. Natural Pozzolan (Class N)
1. Conform to AASHTO M 295.
2. May use instead of fly ash provided that the expansion, according to ASTM C 1567, does not exceed 0.1 percent.

C. Silica Fume: Conform to ASTM C 1240.

2.6 MIX DESIGN

A. Do not place concrete without written approval of the mix design.

B. Do not change the mix design without written approval.

PART 3 EXECUTION

3.1 PREPARATION

A. Aggregate stockpiles:
1. Construct stockpile platforms so that subgrades are prevented from intruding into aggregates.
2. Build stockpiles at least two days before use.
3. Provide an operator and front-end loader to help the Engineer take aggregate samples.
4. Aggregate may be accepted in daily increments, but not more than 30 days before use.
5. Provide separate stockpiles for coarse and fine aggregate.
6. Construct stockpiles to minimize segregation of aggregate.
7. Allow washed aggregates to drain to uniform moisture content before use (12 hours minimum).

3.2 CONCRETE CLASSES AND MIX REQUIREMENTS

A. Meet the requirements in Table 5.

Table 5

Concrete Classes and Mix Requirements							
Class	**Coarse Aggregate or Sieve Size**	**Max. Water/ Cementitous Ratio**	**Min. Cementitous Content (lb/yd^3)**	**Slump (Inch) See Article G for further Criteria**	**Air Content Percent (%)***	**Mix Design Compress *f'*cr (Psi)**	**28 Day Minimum Compress *f'*c (Psi) ****
AA(AE)	2" to No. 4	0.44	564	1 to 3.5	4.0 - 7.0	5200	4000
	1-½" to No. 4	0.44	564	1 to 3.5	4.5 - 7.5	5200	4000
	1" to No. 4	0.44	611	1 to 3.5	5.0 - 7.5	5200	4000
	¾" to No. 4	0.44	611	1 to 3.5	5.0 - 7.5	5200	4000
A(AE)	1-½" to No. 4	0.53	470	1 to 3.5	4.5 - 7.5	3900	3000
	1" to No. 4	0.53	470	1 to 3.5	4.5 - 7.5	3900	3000
	¾" to No. 4	0.48	517	1 to 3.5	4.5 - 7.5	3900	3000
B or B(AE)		0.62	376	2 to 5	-- 3.0 - 6.0	3250	2500

* Values listed represent in-place air content. Make necessary adjustments for impacts to air content due to placement.

** For *f'*c over 4000 psi, design and proportion mixes according to ACI Manual of Concrete Practice 301: Specifications for Concrete and project specific criteria.

B. Minimum strength is based on a coefficient of variation of 10 percent, and one test below the minimum strength per 100 tests.

C. Maximum nominal size of coarse aggregate:
1. Not larger than $^1/_5$ of the narrowest dimension between sides of forms.
2. Not larger than $^1/_3$ the depth of slabs.
3. Not larger than ¾ of the minimum clear distance between reinforcing bars or between bars and forms, whichever is least.

D. Do not exceed water/cementitous ratio.

E. Calculate the water/cementitous ratio (w/c) according to the following formula:

$$\frac{W}{C} = \frac{Water}{Cement + Pozzolan}$$

F. When concrete is deposited in water, use 94 lb more cement per cubic yard than the design requires for concrete placed above water.

G. Use Table 4 to determine the slump requirements when not using water-reducing admixtures or viscosity modifying admixtures.
1. Slump requirements when using low range water reducers: 1 inch to 5 inches for all classes of concrete.
2. Slump requirements when using high range water reducers: 4 inches to 9 inches for all classes of concrete.
3. Slump requirements when using viscosity modifying admixtures: None. Meet visual stability index of 0 – 1.

3.3 BATCHING MATERIALS

A. Meet AASHTO M 157.

B. Meet the requirements of the UDOT Quality Management Plan for Ready-Mix Concrete.

C. Hand Mixing:
1. Only Class B concrete may be hand mixed.
2. Hand-mixed batches cannot exceed 0.5 yd^3.
3. Hand mix on a watertight platform.
4. Spread the aggregate evenly on the platform, and thoroughly mix in the dry cement until the mixture becomes uniform in color.

D. Truck-Mixed Concrete (Dry-Batch):
1. Do not load trucks in excess of their rated mixing capacity, or 63 percent of the drum gross volume, or less than 2 yd^3.

2. The truck rating plate must be readable.

3.4 LIMITATIONS - GENERAL

A. Timing. Unless otherwise specified, place concrete:
   1. Within 90 minutes of batching when the air temperature is below 80 degrees F.
   2. Within 75 minutes of batching when the air temperature is between 80 and 85 degrees F.
   3. Within 60 minutes of batching when the air temperature is between 86 and 90 degrees F.
   4. Prior to initial set.

B. Concrete Temperature: Unless otherwise specified, place concrete in the forms when the concrete temperature is between 50 and 90 degrees F.

C. Pumping and Conveying Equipment
   1. Do not use equipment, or a combination of equipment and the configuration of that equipment, that causes a loss of entrained air content that exceeds one half of the range of air content allowed by specification.
   2. Contractor is responsible for verification and monitoring of air loss.

3.5 CYLINDER STORAGE DEVICE

A. Provide and maintain cylinder storage device.
   1. Maintain cylinders at a temperature range of 60 degrees F to 80 degrees F for the initial 16-hour curing period.
   2. Do not move the cylinders during this period.
   3. Equip the storage device with an automatic 24-hour temperature recorder, which continuously records on a time-temperature chart, with an accuracy of ±1 degree F.
   4. Have the storage device available at the point of placement at least 24 hours before placement.
   5. Engineer stops placement of concrete if the storage device cannot accommodate the required number of test cylinders.
   6. Use water containing hydrated lime if water is to be in contact with cylinders.
   7. A 24-hour test run may be required.

END OF SECTION